



## General

### Guideline Title

Evidence-based guideline: the role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke. Report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology.

### Bibliographic Source(s)

Schellinger PD, Bryan RN, Caplan LR, Detre JA, Edelman RR, Jaigobin C, Kidwell CS, Mohr JP, Sloan M, Sorensen AG, Warach S, Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. Evidence-based guideline: the role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. *Neurology*. 2010 Jul 13;75(2):177-85. [40 references] [PubMed](#)

### Guideline Status

This is the current release of the guideline.

The American Academy of Neurology (AAN) reaffirmed the currency of the guideline in July 2013.

This guideline meets NGC's 2013 (revised) inclusion criteria.

## Recommendations

### Major Recommendations

Definitions of the levels of the recommendations (A, B, C, U) and classification of the evidence (I-IV) are provided at the end of the "Major Recommendations" field.

1. Diffusion-weighted imaging (DWI) should be considered superior to non-contrast computed tomography (CT) scan for the diagnosis of acute ischemic stroke in patients presenting within 12 hours of symptom onset (Level A).
2. There is insufficient evidence to support or refute the value of perfusion-weighted imaging (PWI) in diagnosing acute ischemic stroke (Level U).
3. Baseline DWI volume should be considered useful in predicting baseline clinical stroke severity and final lesion volume in anterior-circulation stroke syndromes (Level B).
4. Baseline DWI volume may be considered not useful in predicting baseline National Institute of Health Stroke Scale (NIHSS) score in posterior-circulation stroke syndromes (Level C).
5. Baseline DWI volume may be considered useful in predicting clinical outcome as measured by the NIHSS and Barthel Index (Level C).
6. Baseline PWI volume may be considered useful in predicting baseline clinical stroke severity (Level C).

## Definitions:

### Classification of Recommendations

Level A = Established as effective, ineffective or harmful (or established as useful/predictive or not useful/predictive) for the given condition in the specified population. (Level A rating requires at least two consistent Class I studies.)\*

Level B = Probably effective, ineffective or harmful (or probably useful/predictive or not useful/predictive) for the given condition in the specified population. (Level B rating requires at least one Class I study or two consistent Class II studies.)

Level C = Possibly effective, ineffective or harmful (or possibly useful/predictive or not useful/predictive) for the given condition in the specified population. (Level C rating requires at least one Class II study or two consistent Class III studies.)

Level U = Data inadequate or conflicting; given current knowledge, treatment (test, predictor) is unproven.

\*In exceptional cases, one convincing Class I study may suffice for an "A" recommendation if 1) all criteria are met, 2) the magnitude of effect is large (relative rate improved outcome >5 and the lower limit of the confidence interval is >2).

### Classification of Evidence for Diagnostic Tests

Class I: A cohort study with prospective data collection of a broad spectrum of persons with the suspected condition, using an acceptable reference standard for case definition. The diagnostic test is objective or performed and interpreted without knowledge of the patient's clinical status. Study results allow calculation of measures of diagnostic accuracy.

Class II: A case control study of a broad spectrum of persons with the condition established by an acceptable reference standard compared to a broad spectrum of controls or a cohort study where a broad spectrum of persons with the suspected condition where the data was collected retrospectively. The diagnostic test is objective or performed and interpreted without knowledge of disease status. Study results allow calculation of measures of diagnostic accuracy.

Class III: A case control study or cohort study where either persons with the condition or controls are of a narrow spectrum. The condition is established by an acceptable reference standard. The reference standard and diagnostic test are objective or performed and interpreted by different observers. Study results allow calculation of measures of diagnostic accuracy.

Class IV: Studies not meeting Class I, II or III criteria including consensus, expert opinion or a case report.

### Classification of Evidence for Prognostic Articles

Class I: A cohort study of a broad spectrum of persons at risk for developing the outcome (e.g., target disease, work status). The outcome is defined by an acceptable reference standard for case definition. The outcome is objective or measured by an observer who is masked to the presence of the risk factor. Study results allow calculation of measures of prognostic accuracy.

Class II: A case control study of a broad spectrum of persons with the condition compared to a broad spectrum of controls or a cohort study of a broad spectrum of persons at risk for the outcome (e.g., target disease, work status) where the data was collected retrospectively. The outcome is defined by an acceptable reference standard for case definition. The outcome is objective or measured by an observer who is masked to the presence of the risk factor. Study results allow calculation of measures of prognostic accuracy.

Class III: A case control study or a cohort study where either the persons with the condition or the controls are of a narrow spectrum where the data was collected retrospectively. The outcome is defined by an acceptable reference standard for case definition. The outcome is objective or measured by an observer who did not determine the presence of the risk factor. Study results allow calculation of measures of a prognostic accuracy.

Class IV: Studies not meeting Class I, II or III criteria including consensus, expert opinion or a case report.

## Clinical Algorithm(s)

None available

## Scope

## Disease/Condition(s)

Acute ischemic stroke

## Guideline Category

Diagnosis

Technology Assessment

## Clinical Specialty

Critical Care

Emergency Medicine

Internal Medicine

Neurology

Radiology

## Intended Users

Hospitals

Physician Assistants

Physicians

## Guideline Objective(s)

To assess the evidence for the use of diffusion-weighted imaging (DWI) and perfusion weighted imaging (PWI) in the diagnosis of patients with acute ischemic stroke

## Target Population

Patients with possible acute ischemic stroke

## Interventions and Practices Considered

Magnetic resonance imaging (MRI)

- Diffusion-weighted imaging (DWI)
- Perfusion weighted imaging (PWI)

## Major Outcomes Considered

Accuracy, sensitivity, and specificity of magnetic resonance imaging (MRI) use in acute ischemic stroke

## Methodology

# Methods Used to Collect/Select the Evidence

## Searches of Electronic Databases

## Description of Methods Used to Collect/Select the Evidence

### 2010 Guideline

The guideline panel sought to answer the following questions regarding the accuracy, sensitivity, and specificity of magnetic resonance imaging (MRI) use in acute ischemic stroke:

1. Are diffusion-weighted imaging (DWI) and perfusion-weighted imaging (PWI) sensitive and specific in the diagnosis of acute ischemic stroke (compared to concurrent imaging with other techniques, established by follow-up imaging, clinical follow-up, and final discharge diagnosis)?
2. Does the volume of the DWI or PWI abnormality predict initial clinical severity, final infarct size, and late clinical outcome?

The panel performed a literature search through January 2008 in the following databases: Medline (starting 1966), EMBASE (starting 1974), Biosis (starting 1969), and Sci (starting 1990). The exact keyword search is available in appendix e-1 of the Data Supplement document (see "Availability of Companion Documents" field).

The panel identified 492 abstracts for question 1 (DWI), 213 for question 1 (PWI), and 210 for question 2. Two panel members reviewed each abstract. Exclusion criteria were as follows: 1) unrelated to acute ischemic stroke <12 hours (question 1) or <24 hours (question 2) after symptom onset or unrelated to questions; 2) unrelated to DWI or PWI (i.e., computed tomography [CT], T2-weighted imaging, Xe-CT, positron emission tomography [PET], single photon emission computed tomography [SPECT]); 3) case report or case series with n<15; 4) review article; 5) letter to the editor or editorial; 6) involving pediatric patients or nonhuman subjects; or 7) nonclinical (e.g., technique development). The eligible publications of each pair were discussed with the whole panel to produce a final list of articles for each question.

The panel chose a time window of 12 hours for question 1 because most treatment studies for acute stroke have an inclusion window of <12 hours. DWI and PWI have a high diagnostic accuracy within the first hours, and effective treatment of acute stroke is negatively correlated with time from symptom onset.

Studies that included patients in a time window exceeding 12 hours were considered for inclusion if a subset of patients <12 hours was reported or the numbers for such a subset could be extracted. For question 2, the panel chose a time window of 24 hours and a sample size of 30 or more for inclusion. Furthermore, they excluded studies in which any patients received thrombolytic therapy so as not to confound the prognostic value of DWI and PWI with regard to the natural disease course.

Recently reported large open series, phase II and III randomized, placebo-controlled trials of MRI-guided IV thrombolysis in acute stroke (DIAS, DEDAS, DIAS-2, EPITHET) are a case in point. These trials selected patients for inclusion up to 9 hours from stroke onset on the basis of a qualitative MRI penumbra pattern. For this assessment, only the placebo groups of these trials would be eligible and helpful in judging diagnostic accuracy (question 1) or predictive value for baseline clinical status and clinical or structural outcome (question 2). No separate imaging data are available for any of these studies yet; in EPITHET, only summary data and the subgroups with PWI/DWI mismatch are presented.

### 2013 Reaffirmation

Medline was searched between 2010 July 13 and 2013 July 13. The following search terms were used: T2weighted or T2(w)weighted) or (FLUID(w)ATTENUATED(w)INVERSION(w)RECOVERY or FLAIR) (Stroke or attack or cerebrovascular accident or apoplexia or apoplexy or CVA or cerebrovascular(w)accident) and (Brain ischemia! or ((brain or cerebr?) and (ischemi? Or ischaemi?)) Diagnostic accuracy or diagnostic error or diagnostic value or receiver operating characteristic or differential diagnosis or "sensitivity and specificity" DT=article or DT=conference paper or DT=journal or DT=review Not case report/dm/human SCI (MRI or magnetic(w)resonance(w)imaging or MR(w)imaging or NMR(w)imaging) and (Perfusion(w)weighted or PWI or PW(w)imaging or perfusion(w)imaging) (SINGLE PHOTON EMISSION COMPUTER TOMOGRAPHY or SPECT) or (Xe(w)CT or xenon(w)CT or Xe(3n)tomography or xenon(3n)tomography) or (COMPUTER ASSISTED TOMOGRAPHY! Or computed(w)tomograph? or CT/ti,ab) or (T2W? or T2weighted or T2(w)weighted) or (FLUID(W)ATTENUATED(W)INVERSION(W)RECOVERY or FLAIR) (Stroke or cerebrovascular(w)accident or apoplexia or apoplexy or CVA) and ((brain or cerebr?) and (ischemi? or ischaemi?)) Diagnosis diagnostic or receiver(w)operating(w)characteristic or sensitivity or specificity DT=article or DT=review NOT (rat or rats or cat or cats or pig or pigs or swine).

Exclusion criteria were as follows: 1) unrelated to acute ischemic stroke <12 hours (question 1) or <24 hours (question 2) after symptom onset or

unrelated to questions; 2) unrelated to DWI or PWI (i.e., CT, T2-weighted imaging, Xe-CT, PET, SPECT); 3) case report or case series with  $n < 15$ ; 4) review article; 5) letter to the editor or editorial; 6) involving pediatric patients or nonhuman subjects; or 7) nonclinical (e.g., technique development).

## Number of Source Documents

Question 1: 4 Class I and II studies

Question 2: 3 Class II studies

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

## Rating Scheme for the Strength of the Evidence

Classification of Evidence for Diagnostic Tests

Class I: A cohort study with prospective data collection of a broad spectrum of persons with the suspected condition, using an acceptable reference standard for case definition. The diagnostic test is objective or performed and interpreted without knowledge of the patient's clinical status. Study results allow calculation of measures of diagnostic accuracy.

Class II: A case control study of a broad spectrum of persons with the condition established by an acceptable reference standard compared to a broad spectrum of controls or a cohort study where a broad spectrum of persons with the suspected condition where the data was collected retrospectively. The diagnostic test is objective or performed and interpreted without knowledge of disease status. Study results allow calculation of measures of diagnostic accuracy.

Class III: A case control study or cohort study where either persons with the condition or controls are of a narrow spectrum. The condition is established by an acceptable reference standard. The reference standard and diagnostic test are objective or performed and interpreted by different observers. Study results allow calculation of measures of diagnostic accuracy.

Class IV: Studies not meeting Class I, II or III criteria including consensus, expert opinion or a case report.

Classification of Evidence for Prognostic Articles

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Class II: A case control study of a broad spectrum of persons with the condition compared to a broad spectrum of controls or a cohort study of a broad spectrum of persons at risk for the outcome (e.g., target disease, work status) where the data was collected retrospectively. The outcome is defined by an acceptable reference standard for case definition. The outcome is objective or measured by an observer who is masked to the presence of the risk factor. Study results allow calculation of measures of prognostic accuracy.

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Class IV: Studies not meeting Class I, II or III criteria including consensus, expert opinion or a case report.

## Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

## Description of the Methods Used to Analyze the Evidence

Evidence was classified using a 4-tier classification scheme for diagnostic (question 1) and prognostic (question 2) articles (see "Rating Scheme for the Strength of the Evidence") and recommendations were based on these levels of evidence (see "Rating Scheme for the Strength of the Recommendations"). If more than one publication from identical groups entered data extraction, the manuscripts were assessed for the same patients being used in different analyses. In this case, the publication with the highest class of evidence and patient number was included. After the selection process, panel members discussed potentially relevant publications that could change the level of recommendation. These studies were included or excluded by consensus.

## Methods Used to Formulate the Recommendations

Expert Consensus

## Description of Methods Used to Formulate the Recommendations

### 2010 Guideline

A panel of neurologists, neuroradiologists, and radiologists was assembled. Recommendations were based on the level of evidence (see "Rating Scheme for the Strength of the Recommendations").

### 2013 Reaffirmation

An author conducted a literature search using the same criteria as presented in the original guideline. Because the guideline recommendations would not change given the new literature available, the committee voted to reaffirm the guideline, stating that the conclusions and recommendations are still valid.

## Rating Scheme for the Strength of the Recommendations

### Classification of Recommendations

The strength of practice recommendations is linked directly to the level of evidence:

Level A = Established as effective, ineffective or harmful (or established as useful/predictive or not useful/predictive) for the given condition in the specified population. (Level A rating requires at least two consistent Class I studies.)\*

Level B = Probably effective, ineffective or harmful (or probably useful/predictive or not useful/predictive) for the given condition in the specified population. (Level B rating requires at least one Class I study or two consistent Class II studies.)

Level C = Possibly effective, ineffective or harmful (or possibly useful/predictive or not useful/predictive) for the given condition in the specified population. (Level C rating requires at least one Class II study or two consistent Class III studies.)

Level U = Data inadequate or conflicting; given current knowledge, treatment (test, predictor) is unproven.

\*In exceptional cases, one convincing Class I study may suffice for an "A" recommendation if 1) all criteria are met, 2) the magnitude of effect is large (relative rate improved outcome >5 and the lower limit of the confidence interval is > 2).

## Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

## Method of Guideline Validation

External Peer Review

Internal Peer Review

## Description of Method of Guideline Validation

Drafts of the guideline have been reviewed by at least three American Academy of Neurology (AAN) committees, a network of neurologists, *Neurology*® peer reviewers, and representatives from related fields.

This guideline was approved by the Therapeutics and Technology Assessment Subcommittee on November 15, 2008; by the Practice Committee on August 4, 2009; and by the American Academy of Neurology (AAN) Board of Directors on April 25, 2010.

## Evidence Supporting the Recommendations

### Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see "Major Recommendations" field).

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Increased accuracy of diagnosis of acute ischemic stroke within 12 hours of symptom onset

### Potential Harms

The true sensitivity of diffusion-weighted imaging (DWI) for the diagnosis of ischemic stroke is not 100% and is probably closer to 80% to 90% in a general sample of patients presenting for emergency evaluation of possible stroke. Increasingly, however, cases of DWI-negative stroke were reported. False-negative DWI in ischemic stroke may be attributable to mild (small) strokes, brainstem location, and the earliest times from onset, and may become less frequent as imaging technology continues to improve.

## Qualifying Statements

### Qualifying Statements

This statement is provided as an educational service of the American Academy of Neurology (AAN). It is based on an assessment of current scientific and clinical information. It is not intended to include all possible proper methods of care for a particular neurologic problem or all legitimate criteria for choosing a specific procedure. Neither is it intended to exclude any reasonable alternative methodologies. The AAN recognizes that specific patient care decisions are the prerogative of the patient and the physician caring for the patient, based on all of the circumstances involved. The clinical context section is made available in order to place the evidence-based guideline(s) into perspective with current practice habits and challenges. No formal practice recommendations should be inferred.

## Implementation of the Guideline

### Description of Implementation Strategy

An implementation strategy was not provided.

### Implementation Tools

Foreign Language Translations

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

## Institute of Medicine (IOM) National Healthcare Quality Report Categories

### IOM Care Need

Getting Better

### IOM Domain

Effectiveness

Timeliness

## Identifying Information and Availability

### Bibliographic Source(s)

Schellinger PD, Bryan RN, Caplan LR, Detre JA, Edelman RR, Jaigobin C, Kidwell CS, Mohr JP, Sloan M, Sorensen AG, Warach S, Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. Evidence-based guideline: the role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. *Neurology*. 2010 Jul 13;75(2):177-85. [40 references] [PubMed](#)

### Adaptation

Not applicable: The guideline was not adapted from another source.

### Date Released

2010 Jul (reaffirmed 2013 Jul 13)

### Guideline Developer(s)

American Academy of Neurology - Medical Specialty Society

### Source(s) of Funding

American Academy of Neurology (AAN)

### Guideline Committee



## Composition of Group That Authored the Guideline

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## Financial Disclosures/Conflicts of Interest

The American Academy of Neurology (AAN) is committed to producing independent, critical and truthful clinical practice guidelines (CPGs). Significant efforts are made to minimize the potential for conflicts of interest to influence the recommendations of this CPG. To the extent possible, the AAN keeps separate those who have a financial stake in the success or failure of the products appraised in the CPGs and the developers of the guidelines. Conflict of interest forms were obtained from all authors and reviewed by an oversight committee prior to project initiation. AAN limits the participation of authors with substantial conflicts of interest. The AAN forbids commercial participation in, or funding of, guideline projects. Drafts of the guideline have been reviewed by at least three AAN committees, a network of neurologists, Neurology® peer reviewers, and representatives from related fields. The AAN Guideline Author Conflict of Interest Policy can be viewed at [www.aan.com](http://www.aan.com)

For a detailed report of the authors' disclosures, refer to the "Disclosure" section of the original guideline document.

## Guideline Status

This is the current release of the guideline.

The American Academy of Neurology (AAN) reaffirmed the currency of the guideline in July 2013.

This guideline meets NGC's 2013 (revised) inclusion criteria.

## Guideline Availability

A list of American Academy of Neurology (AAN) guidelines, along with a link to this guideline, is available at the [AAN Web site](http://www.aan.com)

Print copies: Available from the AAN Member Services Center, (800) 879-1960, or from AAN, 201 Chicago Avenue South, Minneapolis, MN 55415.

## Availability of Companion Documents

The following are available:

- Evidence-based guideline: the role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke. Data supplement (e-appendices and e-references). Available from the [Neurology Web site](http://www.aan.com).
- The role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke. Clinician summary. American Academy of Neurology (AAN) summary of evidence-based guideline for clinicians. St. Paul (MN): American Academy of Neurology. 2010. 2 p. Available from the [AAN Web site](http://www.aan.com) .
- American Academy of Neurology (AAN) guideline development process [online]. St. Paul (MN): American Academy of Neurology. Available from the [AAN Web site](http://www.aan.com) .

In addition, Chinese and Korean translations of the original guideline document are available from the [Neurology Web site](#)

## Patient Resources

None available

## NGC Status

This summary was completed by ECRI Institute on March 4, 2011. The currency of the guideline was reaffirmed by the developer in July 2013 and the summary was updated by ECRI Institute on December 22, 2015.

## Copyright Statement

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## Disclaimer

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